A longtitudinal study of the impact of wind turbine proximity on health related quality of life.

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ABSTRACT

Background.

Wind turbine noise is known to cause annoyance and sleep disturbance, which are primary health effects. An additional risk factor is the trait of noise sensitivity, which describes individuals who are more likely to pay attention to sound, evaluate sound negatively and have stronger emotional reactions to noise. The result is chronic stress, the effects of which could be monitored through detecting stress related outcomes such as hypertension in exposed individuals. An alternative approach is to monitor health related quality of life (HRQOL). This study examines whether there is a change in this metric over time in a turbine exposed community.

Methods.

This is a 2 year follow up of a base-line survey carried out on individuals living within two kilometres of industrial wind turbines compared with a matched control group[1]. We have repeated the self administered questionnaire survey in which self-reported HRQOL was measured using the abbreviated version of the WHOQOL-BREF.

Results.
The base-line survey found that residents living within 2 km of a turbine installation experienced significantly lower overall quality of life, physical quality of life, and environmental quality of life than a control group. The turbine group showed no change in WHOQOL or amenity scores with time, however compared to the 2012 control group, the turbine group had lower physical domain scores, and rated their overall health as being poorer. The results do not therefore support any improvement in this global health metric with time.

Keywords: Wind turbine exposure, health related quality of life.

1. INTRODUCTION

The need to reduce reliance on fossil fuels has led to increased interest in wind turbines as a source of sustainable energy. Although wind turbine technology has been around for at least thirty years, the last ten years or so in New Zealand have seen a rapid increase in construction of wind farms and also of complaints about their effects, particularly the possible health effects. In New Zealand, the Resource Consent process, required under the Resource Management Act (1991), takes health effects into account. Legal decisions have however been informed, thus far at least, by a simple 'direct health effect' model. Wind farm noise, lying as it does in the Makara area between levels of 20 dB(A) and 54 dB(A)[2], is simply not loud enough to cause the main adverse health effect associated with noise, that is to say noise induced hearing loss. Other adverse effects, such as anxiety and annoyance, are said to result from misconceptions that individuals develop about the noise. Acclimatization is considered as being helpful in resolving this psychological sensitization[3].

Alternative models attempt to explain how Turbine noise can lead to annoyance and sleep disturbance, which indirectly lead to physiological upset, or can induce annoyance by degrading amenity. The long-term outcomes of environmental stressors, such as hypertension or heart disease, are however difficult to examine, bearing in mind the relatively small numbers of exposed persons.

This has led to alternative approaches, including the 'global' assessment facilitated by the subjective appraisal of health-related quality of life (HRQOL), a concept that measures general well-being and well-being in the physical, psychological, and social domains. HRQOL is related to health by the WHO (1948) definition of health as 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.' This seems a suitable concept with which to encapsulate the health of a community.

At present the research into these health effects is at a hypothesis generating stage and not at such a level of proof that relates cause and effect with any degree of certainty. Conversely it is not possible to argue categorically that there will be no health effects. Longer term effects are obviously important: this study was carried out to study how HRQOL changes over 2 years in a community living within 2 km of a turbine installation and compares HRQOL in a control group over the same period.

2. MATERIALS AND METHODS

2.1 Design

The design was a repeated cross-sectional survey.

2.2 Sample

The 'turbine group' lived in the Makara Valley, 10 km west of Wellington, the New Zealand Capital city. We identified fifty-six houses lying within a 2 km radius of a wind turbine. Noise measurements had indicated that sound levels, although largely consistent with consent conditions based on the $L_{95\ (10\ min)}$ exposure metric, still lay in a range between 20 dB(A) and 54 dB(A)[2]. An independent investigation had shown that amplitude modulation effects such as 'rumble-thump' were also evident[4]. The control group was selected from two hundred and fifty houses situated in a geographically and socioeconomically matched area, but at least 10 km from a turbine installation.

2.3 Data collection

The WHOQOL-BREF is a 26-item version of the WHOQOL-100 assessment. This instrument

offers composite measures of physical (seven items), psychological (six items), and social (three items) HRQOL, an additional eight item domain measuring environmental QOL and two 'generic' items asking about general health and overall quality of life. Two amenity items were included: 'I am satisfied with my neighbourhood/living environment' and 'My neighbourhood/living environment makes it difficult for me to relax at home.' The relevant items were presented by way of a five point scale with appropriate descriptors anchoring each end. Each house received two copies of the questionnaire, which was sent by mail and included a pre paid envelope. The instrument was anonymised, the title '2012 wellbeing and neighbourhood survey' being designed to mask the true intent of the study. The base-line survey was carried out in 2010, with the follow up in 2012.

2.4 Statistical analyses.

Exploratory data analyses were performed and hypothesis testing carried out using IBM SPSS Statistics version 10. Distributions of the HRQOL domain variables are presented as box and whisker plots, and were examined for normality using P-P plots. Before and after comparisons for variables which conformed reasonably to a normal distribution were carried out using an independent samples t-test, during which the equality of variance was examined by Levenes test. Non parametric data was analysed by way of the independent samples Mann-Whitney U test.

3. RESULTS

The WHOQOL-BREF scores for the two survey rounds are shown as box-plots in figure 1. Five cases were excluded from the comparison group because they were multivariate outliers as defined by extreme Mahalanobis distances, with response set acquiescence clearly evident in all five cases

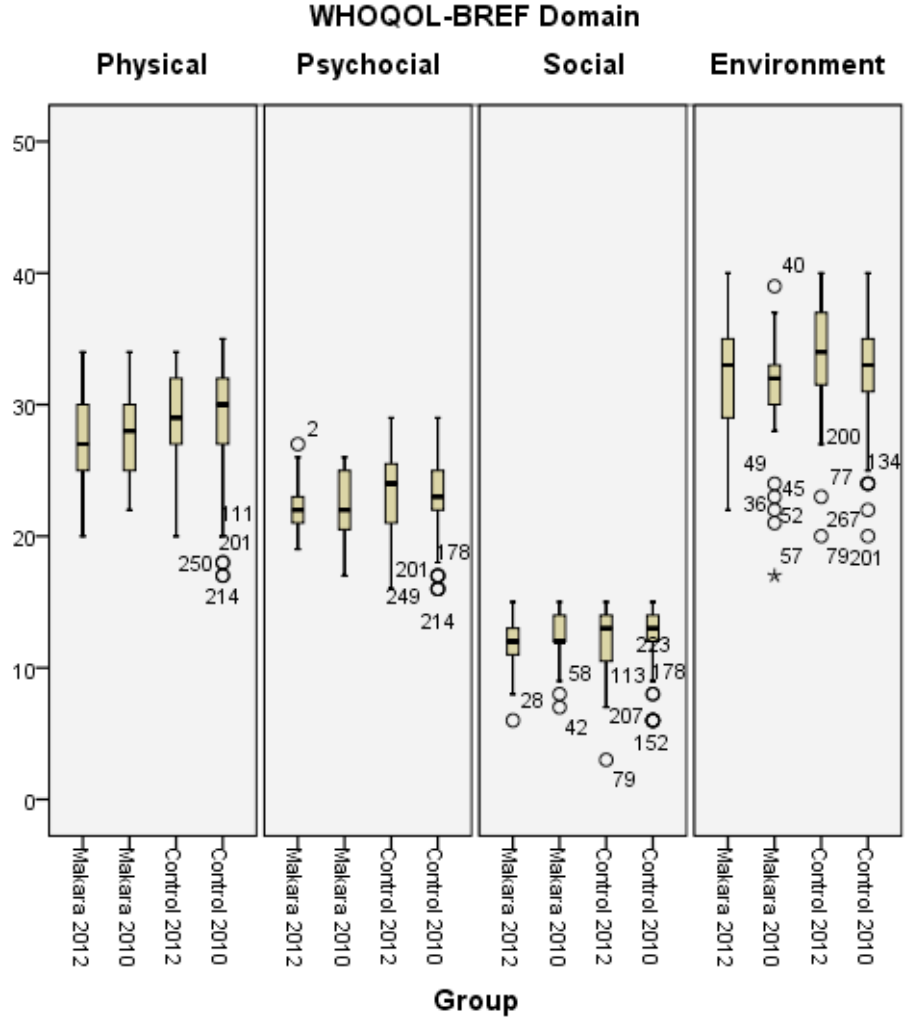

Figure 1, box-plot of WHOQOL-BREF domain scores for turbine and control groups.

Comparing the WHOQOL scores between base-line and follow up for the Makara residents, they tended to be similar as regards to psychosocial and social scores, slightly decreased for the physical domain and somewhat improved in the environmental domain, but none of these differences were statistically significant.

Comparing WHOQOL scores in Makara residents with the 2012 control group, Makara residents tended to score more poorly in the psychosocial and environment domains, significantly so in the physical domain (Mann-Whitney U test, p = .043) in which the Makara follow up group had a mean rank of 29.28 compared to the controls who had a mean rank of 39.15.

Examination of the scores of the individual questions showed that Makara residents scored significantly more poorly (p = .020) for WHOQOL question 2, 'how satisfied are you with your health' with a mean rank of 29.79 compared to the mean rank in controls of 39.52.

The Amenity scores are shown in figure 2.

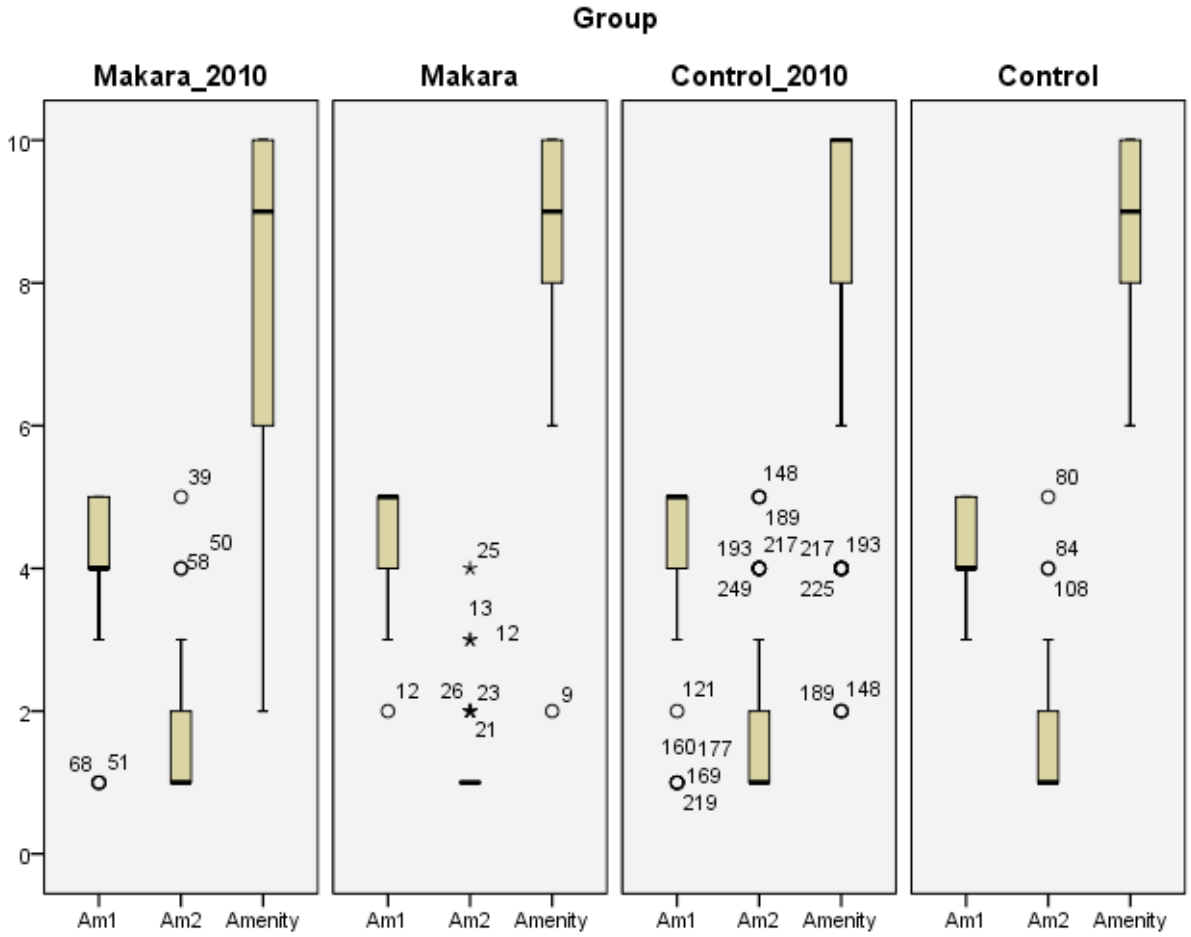

Figure 2, box-plot of amenity scores for turbine and control groups.

Neither of the amenity questions 'I am satisfied with my neighbourhood/living environment' and 'my neighbourhood/living environment makes it difficult for me to relax at home' showed any significant difference in scores over time. There was however a significant decrease in amenity in the control group over time (p = .034): the mean rank in 2010 was 103.4 and that in 2012 was 85.13.

4. DISCUSSION

The results indicate that, compared to the control group, Makara residents scored more poorly in the physical WHOQOL domain, and also rated themselves as having poorer overall health. For this group there was however no difference in the WHOQOL or amenity scores over time.

The strength of the 2010 study was the masking of intent and the geographical and social matching. The intent masking may not however have carried through to the second round, the results of the initial survey having been published. The study would also have been more powerful had we been able to follow up individuals rather than the community. In addition, the size of the exposed group is also relatively small: wind farms in New Zealand are often situated in complex terrain, and tend to have fewer individuals living close to the source. This also reduces the power to detect real associations.

Bias may be present, in terms of response bias from those who answered the questionnaire in the Makara area, who may have been those most affected, which would have tended to increase the association between turbine proximity and HRQOL. Conversely it is also possible that residents may have moved away from the Makara area because of noise, however the number involved is unlikely to be high and probably does not bias the results to any significant extent.

The main comparative body of evidence is the 2010 survey round[1], when the turbine group reported lower physical and environmental scores compared to the control group. The deficit in the physical domain seems to have been maintained, and on this occasion the self-rated reported health of the turbine group was poorer. There were therefore some changes in perception over time, but no improvement. In the previous round both energy levels (question 10) and sleep quality (question 16) were lower in the turbine group compared to controls. In the environmental domain, Makara residents considered their environment to be less healthy (question 9) and they were less satisfied with their living space (question 23). In the second round, sleep quality and energy levels tended to be slightly lower, but not significantly so, whereas there was no difference in the healthy environment or living space scores.

The present analysis neither includes annoyance, nor does it measure noise sensitivity, both of which are likely to be involved in the model which explains individual variability in the response to noise[1]. There is an argument that the effects are psychogenic and sociogenic[5]. If so, the effect might be expected to moderate over time, however there is no evidence of it in this group. As regards future work, there appears to have been little effort expended in collecting longtitudinal data on the health effects caused by wind turbine proximity. There seems to be a strong argument for doing so.

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